

CenSoC News & Views

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A Matter of Scale

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Welcome to the first of what we intend as a regular feature on our website of “CenSoC News & Views” (N&V). N&V will feature op-ed pieces from members of CenSoC and CenSoC associates, as well as contributed pieces by others. N&V provides an opportunity to pass along recent and breaking news about CenSoC activities and research, and an outlet for opinion pieces that reflect individual views on various subjects and topics.

This N&V piece is about the scale parameter associated with all latent dependent variable statistical models. That is, all choice models have an embedded scale parameter that is perfectly inversely related to the variance of the errors. Scale and error variance cannot be separately identified, so one typically sets the scale equal to a convenient constant like unity, which then allows analysts to recover choice model parameters “up to scale”.

At the First Invitational Choice Symposium that I proposed, organised and hosted in Banff, Alberta, Canada in 1989, Taka Morikawa noted that random utility theory required that if the preferences underlying two sources of choice data were identical, the estimated preference parameters from the two sources must be proportional; with the constant of proportionality equal to the ratio of the scales of one source relative to the other. Taka presented the results of an analysis of stated and revealed preference data sources for transport mode choice in the Netherlands, and his results supported the hypothesis that the preferences underlying the two data sources were the same. Taka’s ideas were further elaborated by Swait and Louviere (*Journal of Marketing Research* 1993), who provided a now widely-used test of the equivalence of preferences in two or more sources of data.

Surprisingly, many in the academic choice modeling community came to think that the notion of comparing different sources of preference data is the primary role of the scale parameter in choice models, but this is too simplistic a view. In particular, CenSoC researchers and associates have conducted research on the role of the scale parameter since the early 1990s, following Morikawa’s insights. Unlike many academics and practitioners who work with choice models, this small group of researchers realized that the implications of scale went well beyond simply comparing preferences in different data sources. Specifically, they recognized that virtually all operational and published choice models assume that errors are independent and identically distributed (so-called “IID errors”). Unfortunately, if this assumption is not true, potentially large biases in estimated models can result due to confounds with scale parameters.

Even more surprisingly, many academic and applied choice modelers seem unaware that the error variance (or equivalently, the inverse of scale) not only can vary within and between individual choosers, but also can vary as a function of variables manipulated in experiments

or real markets, misspecification and differences in choice contexts, geographies, time and individual characteristics. Several working papers on the CenSoC website and others published in major academic journals consistently and clearly demonstrate that scale varies with these various sources. Until recently, this work was largely ignored by the general choice modeling community, but this has finally started to change as a result of an aggressive campaign by CenSoCers and others to make it clear that there are major issues associated with ignoring variation in scale in the current choice modeling paradigm. For example, CenSoCers put on a special session at the 2006 Marketing Science Conference in Pittsburgh, Louviere and Eagle gave a hard-hitting talk on the issue at the 2006 Sawtooth Software Conference in Delray Beach, Florida, Keane and Louviere presented a significant amount of recent evidence on the role of scale within the context of a more general choice model developed by Keane (called “Generalised Logit”) at the 2007 Invitation Choice Symposium at Wharton, and CenSoCers gave a series of talks on scale and related topics at the recent 2007 Marketing Science Conference in Singapore. So, it appears that a growing number of academics and practitioners now realize that scale plays a rather fundamental and far-reaching role in choice models, and our understanding of this role is really in its infancy. Indeed, what is needed is a behavioural theory of the scale parameter, and how it might vary with respect to a wide range of phenomena.

Thomas Kuhn wrote a highly influential book on the history and sociology of science (*The Structure of Scientific Revolutions*). Among many observations that Kuhn made about how science progresses and scientists behave were several pertinent observations about how scientists come to see major problems and issues in scientific paradigms, and how the scientists involved in such paradigms tend to react to such changes. I say this because the results of research by CenSoCers and others on scale pose a crisis for current choice modeling paradigms. That is, it is now clear that failure to properly capture scale can lead to serious bias in choice models, yet the trend in the field over the past 15 years has been to develop ever more complex and flexible statistical models. When CenSoCers have presented talks on the implications of non-constant scale in choice models, many in the audience have reacted exactly as Kuhn describes – they immediately defend the status quo, and suggest that this can all be “fixed” by “simply doing this or that”. The “this or that” typically involves adding more flexibility to choice model specifications, which in turn involves adding parameters to capture more “latency”. So, for example, a typical reaction is to point out that one can estimate a more flexible variance-covariance structure for the errors and/or the random parameters, or that one can “simply” apply “mixtures of normals” that can approximate any unknown choice process. While these defenses of the paradigm are “technically” true, they entirely miss the point.

Indeed, the point is that underlying causes of non-constant scale parameters need to be understood and explained, not merely “fixed” by more general statistical models. While more general and flexible statistical specifications in fact can capture scale differences, one needs to be cautious about their development and use because they also may a) over-fit estimation data, b) experience difficulties in out-of-sample predictions, and c) be impacted by departures from idiosyncratic variability present in estimation data sets. Thus, the field needs to ask whether such models are the answer to the current “scale crisis”, or possibly part of the

problem if they encourage researchers to ignore the underlying behavioural phenomena by thinking that flexible forms solve the problem.

What we need is a true paradigm revolution in the Kuhnsian sense, with choice modeling researchers and practitioners recognising that the future of the field lies in better and richer behavioural theory, particularly behavioural theory that can help us to understand the hows and the whys of varying scales.

We in CenSoC hope to play a continuing role in this important area.